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Quarterly Report

Date of Report: October 15, 2009

Contract Number: DTPH56-05-T-0001

Prepared for: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

Project Title: "Understanding Magnetic Flux Leakage (MFL) Signals from Mechanical Damage in Pipelines"

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For quarterly period ending: September 30, 2009

Technical Status

TASK 11: Experimental MFL measurements and MFL modeling of gouges in full-scale pipe sections

A team of Queen's University researchers (Prof. Lynann Clapham, Dr. Vijay Babbar and Mr. Jia Dian Chen) traveled to Stress Engineering Services (SES), in Houston, Texas, from August 26 to September 6 to make experimental MFL measurements on gouged mechanical damage defects created on pressurized pipeline sections. SES procured five 12.75-inch x 0.375-inch Grade X42 pipeline sections, and installed a pair of gouges (one at 100% and the other at 50% MAOP) on each pipe section, thus producing a total of 10 gouges.

The gouges were produced using a tool which had a rectangular cross section, having a leading edge which was flat and approximately ½ inch wide. This tool was chosen because it had been previously used by SES for an extensive gouging study. The length of each gouge was approximately 2-inches, while the depth (measured during the indentation process) varied from 0.100 to 0.500 inches, with the pairs of gouges produced for each pipe having the same depth and each pipe having a unique gouge depth. The detailed specifications of the samples are given in Table 1 below. The geometry of the gouges represents a more extreme case than the GDF Suez (GDF) gouges studied earlier, in that the flat leading edge of the tool created a situation where the exfoliated material was pushed forward, ahead of the indenter, rather than to the side as had been observed earlier with the GDF gouges. The large region of accumulated material at the end of each gouge strongly affected the measured MFL signal; as such all of the modeling work has needed to be modified for the new geometry. This modeling work continues and is expected to be complete by the end of the following quarter.

The MFL measurements were made over the gouged region outside the pipe at a pressure of 50% MAOP (890 psi). In addition, one of the pipes (Pipe # 3) was pressure cycled and measurements were made after 10, 100 and 1000 cycles. Following the initial measurements at the outer pipe surface during 50% MAOP pressurization, SES cut each pipe into shorter (~2ft long) cylinder sections and shipped them to Queen's for further (internal and zero-pressure) measurements. This work will be completed in the next quarter.

TASK 12: Neutron diffraction measurements on GDF Suez gouged samples

The work on neutron diffraction measurements on GDF Suez gouges could not be carried out because of the NRU reactor shut down at Chalk River Laboratories. The work will be resumed as soon as the reactor becomes operational, which will likely be in the final quarter of this project.

Table 1: Test Matrix Specifications of SES Gouges

Pipe #	Gouge #	Internal Pressure (psi)	Fatigue Cycles	Gouge Depth during gouging (mils)	Gouge Length (inches)
1	1A	1780	No	100	2
	1B	890	No	100	2
2	2A	1780	No	250	2
	2B	890	No	250	2
3	3A	1780	Yes	250	2
	3B	890	Yes	250	2
4	4A	1780	No	375	2
	4B	890	No	375	2
5	5A	1780	No	500	2
	5B	890	No	500	2

Business Status

The project is coordinated with the DOT PHMSA project DTPH56-06-T-000016 “Consolidated Program on In-Line Inspection Technologies” through PRCI. This coordination ensures that the results from this project are being continually communicated to companies such as Rosen, Battelle, and Blade. The status of the total budget is summarized in the table below

Task # Task Description	Federal Funding			Cost Share Funding		
	Budget	Expended (Actuals) This Quarter	Expended (Actuals) to Date	Budget	Expended (Actuals) This Quarter	Expended (Actuals) to Date
Project Total	\$258,767	\$18,000	\$234,061	\$260,855	\$17,570	\$213,926

Schedule

Most of the Tasks are on schedule except for the neutron diffraction measurements on GDF gouged samples. This was delayed because of NRU reactor shut down at Chalk River Laboratories. The work will resume as soon as the reactor becomes operational.

Payable Milestones

Task status for this period includes (only tasks for Phase IV are shown):

Task No.	Task	Status	Scheduled Completion Date	Payable Milestone (Item No)
11	Experimental MFL measurements and MFL modeling of gouges in full-scale pipe sections	60% Complete	09/30/2009	66, 68
12	Neutron Diffraction measurements on GDF Suez gouged samples	5% Complete	09/30/2009	65, 69

4	Administration and Reporting	On-Going	03/31/2010	70
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Results and Conclusions

Task # 11.2: The work on MFL modeling of SES dent+gouge defects is in progress. The previous MFL models reflected geometries of GDF gouges, which were of non-uniform width with pointed ends and had only a small quantity of the exfoliated material at the trailing end of the gouge. The SES gouges, on the other hand, had almost uniform width and quite a significant amount of exfoliated material at the trailing end. This necessitated additional work on structural as well as MFL modeling, which is in progress.

Task # 11.5: SES procured five full-scale 12.75-inch x 0.375-inch Grade X42 pipeline sections and welded end caps. Two gouges were installed 180° apart on each pipe, one at a pressure of 100% MAOP and the other at 50% MAOP, thus producing a total of 10 samples. A photograph of one of the gouges is shown in Figure 1. The length of each gouge was about 2-inches and the depth was varied from 0.100 to 0.500 inches from one pipe section to another. The detailed specifications of the gouges are given in Table 1 above. One of the pipeline sections was pressure cycled up to 1000 cycles, with MFL measurements made at specific intervals, as described below.

Task # 11.6: The Queen's team visited SES to make in-situ MFL measurements on gouged samples. Both radial and axial MFL measurements were made over the gouged region on the outer side of the pipe at a constant pressure of 50% MAOP (890 psi). Figures 2 and 3 show the typical axial and radial MFL scans from Gouge # 5B taken at a pressure of 50% MAOP. As observed from these figures, the strongest signal is produced from the exfoliated material accumulated near the left end of the gouge; the signal from the other parts of the gouge is correspondingly suppressed. MFL results from other gouges had the same form. One of the pipes (Pipe # 3) was also pressure cycled and measurements were made after 10, 100 and 1000 cycles. SES proposed to cut the sample coupons and transport them to Queen's to enable the team to make zero-pressure scans over the defect regions on both outside and inside the pipe section.



Figure 1: Photograph of Gouge # 5B installed at a pressure of 50% MAOP.

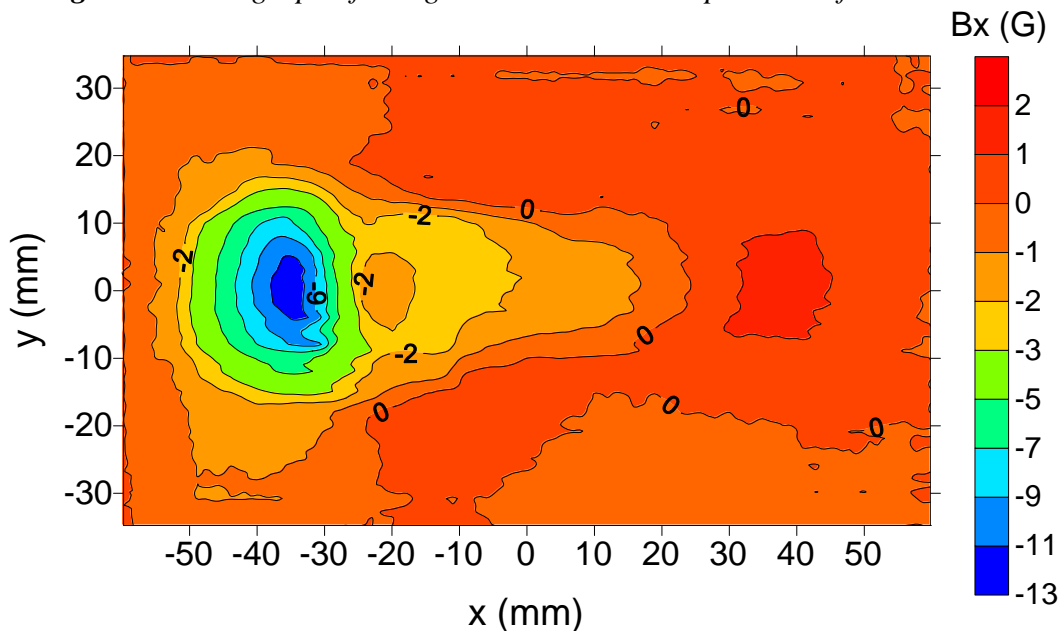


Figure 2: MFL axial scan of Gouge # 5B taken at a pressure of 50% MAOP.

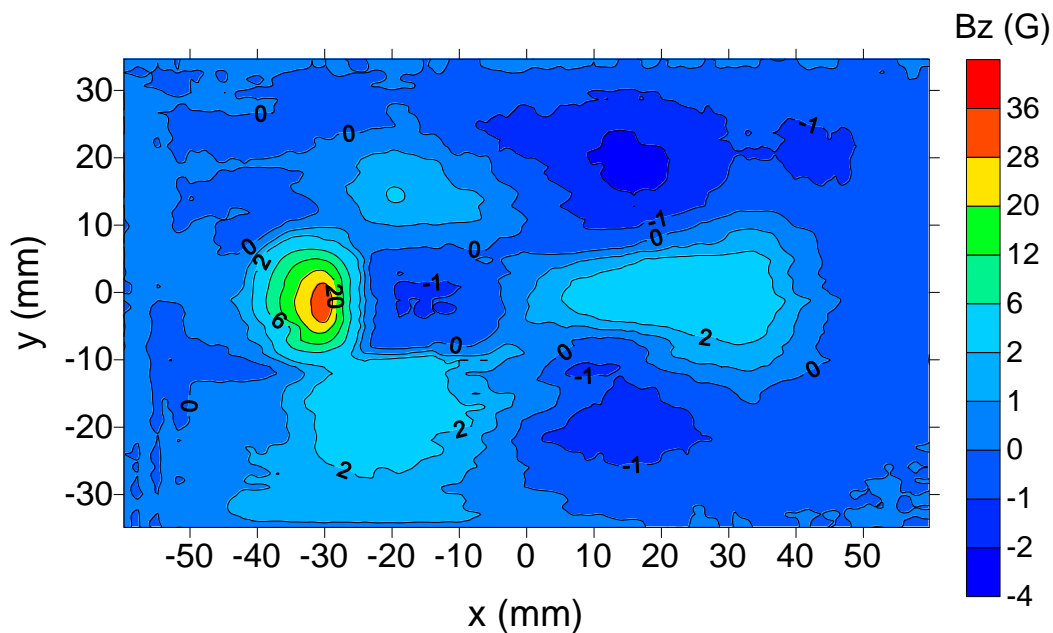


Figure 3: MFL radial scan of Gouge # 5B taken at a pressure of 50% MAOP.

Task # 12.2: The work on neutron diffraction measurements on P22 gouge from GDF gouges could not be carried out because of the NRU reactor shut down at Chalk River Laboratories. The work will be resumed as soon as the reactor becomes operational, which will likely be in the final quarter of this project.

Task # 12.3: Since the NRU reactor at Chalk River is non-operational, the proposal to CNBL for neutron diffraction measurements on BEA159 sample from GDF has not been submitted. It will be done as soon as the reactor becomes operational.

Issues, Problems or Challenges

There were no issues or problems in the current quarter, except for the neutron diffraction work, which has been withheld due to problems with the NRU reactor.

Plans for Future Activity

The following work is planned for the next quarter:

- MFL scanning of SES gouges at zero pressure from both outside and inside the pipeline section.
- Continue MFL modeling of SES gouges and compare modeling and experimental results.
- Analysis of MFL signals from experiment and modeling.
- When the NRU reactor at Chalk River Laboratories becomes operational, neutron diffraction studies will be undertaken on GDF samples. A proposal for neutron diffraction measurements on samples BEA159 and BEA161 will be prepared and submitted.
- Monthly Status Updates will be submitted.
- Eighteenth Quarterly Report will be submitted.